

Posterior malleolus fixation in trimalleolar fractures: comparison of functional outcomes of plate and screw methods

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ABSTRACT

Aims: This study was planned to compare the clinical outcomes of plate and cannulated screw fixation methods for the posterior malleolus (PM) component in trimalleolar ankle fractures and to evaluate the effect of the time from trauma to surgery and the presence of dislocation on postoperative function.

Methods: This retrospective study included 44 patients who underwent surgical treatment with PM fixation for trimalleolar fractures between 2019 and 2023. Patients were grouped by fixation method: screw (n=19) and plate (n=25), with all surgeries performed via a posterolateral approach. Functional outcomes were assessed using the American Orthopaedic Foot and Ankle Society (AOFAS) ankle-hindfoot score at 6, 12, and 24 months. The presence of ankle dislocation and time from trauma to surgery (<24 vs. >24 hours) were recorded.

Results: AOFAS scores showed no significant difference between plate and screw groups at any time point (p>0.05). However, patients with dislocation had significantly lower scores at all follow-ups (p<0.05). Timing of surgery had no significant effect on outcomes. Loss of reduction was rare (n=2).

Conclusion: Plate and screw fixation yield comparable functional outcomes in PM fractures. Dislocation negatively impacts recovery, while surgical timing does not. Emphasis should be placed on anatomical reduction and addressing prognostic factors for optimal results.

Keywords: Cannulated screw, plate fixation, posterior malleolus, trimalleolar fracture

INTRODUCTION

The ankle joint is frequently exposed to trauma due to its weight-bearing nature and complex biomechanics. Trimalleolar fractures are characterized by the simultaneous fracture of the medial, lateral, and posterior malleolus (PM), and are considered a more complex fracture pattern with prognostic implications, particularly due to the involvement of the PM component.¹ Posterior malleolar fractures are associated with poor clinical outcomes, increased instability, and the development of post-traumatic arthritis.²

For many years, surgical fixation of the PM fragment was recommended only in fractures involving more than 25% of the articular surface. However, it is now understood that fragment size alone is not sufficient for surgical decision-making; assessments based on fracture morphology, presence of dislocation, articular surface depression, syndesmotic instability, and classifications such as Haraguchi are considered more meaningful.^{3,4}

The main surgical techniques used for stabilization of posterior malleolar fractures are screw fixation (anteroposterior or

posteroanterior) and plate fixation (buttress plate). Posterior plate fixation has been shown in some studies to be superior due to providing better biomechanical stability and allowing more accurate anatomic reduction.^{5,6} However, screw fixation offers advantages such as being less invasive, involving a shorter operative time, and having fewer soft tissue complications.⁷

Recent systematic reviews and meta-analyses have reported that plate fixation is associated with better American Orthopaedic Foot and Ankle Society (AOFAS) ankle-hindfoot score scores, shorter bone healing time, less pain, and lower complication rates.^{6,8} Nonetheless, some studies have found no significant difference between the two methods and have even suggested that screw fixation also provides satisfactory clinical outcomes.⁹

This study was planned to guide the patient-specific decision-making process of the fixation method for the PM. In this context, our first aim was to compare the effects of plate and screw fixation methods used for the PM component in trimalleolar fracture surgery on the clinical and radiological

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results of the patients. Our other aim was to evaluate the effect of the time interval between trauma and surgery and the presence of dislocation at first presentation on the clinical results.

METHODS

This single-center, retrospective clinical study was conducted by examining the data of patients who underwent surgical treatment for trimalleolar ankle fractures at the Ankara Bilkent City Hospital Orthopedics and Traumatology Clinic between 2019 and 2023. Approval for the study was obtained from Ankara Bilkent City Hospital Medical Researches Scientific and Ethical Evaluation Committee No. 1 (Date: 26.03.2025, Decision No: TABED 1-25-1152). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

Inclusion criteria were determined as being between the ages of 18 and 65, being diagnosed with a trimalleolar ankle fracture, having surgical fixation applied to the posterior malleolar component, and having at least two years of postoperative clinical follow-up.

Exclusion criteria were determined as being younger than 18 or older than 65, having a history of previous surgery on the same ankle, and having a simultaneous tibial pilon fracture or open fracture. A total of 44 patients were included in the study in line with these criteria.

All patients underwent preoperative ankle anteroposterior (AP), lateral and mortise radiographs and computed tomography (CT) examinations. PM fractures were evaluated using the Haraguchi classification based on CT images.

In surgical treatment, fixation was performed in the same order in all patients: first the lateral malleolus, then the PM, and finally the medial malleolus. Posterolateral incision was preferred for lateral and PM fixation, while medial longitudinal incision was preferred for medial malleolus fixation. The lateral malleolus was fixed with open reduction and tubular or anatomic plates in all cases. Medial malleolus fractures were fixed with two 3.5 mm cannulated screws in each patient. Syndesmosis was assessed intraoperatively after fixation, and syndesmotic screws were placed through the lateral malleolus plate in patients with instability.

The fixation method of PM fractures was determined according to the surgeon's intraoperative preferences. In cases where cannulated screws were used, two or three 3.5 mm screws were applied depending on the size of the fragment. In patients where plate fixation was performed, a support plate was used. All surgical procedures were performed by the same orthopedic and traumatology team.

Evaluations

The time between trauma and surgical intervention was analyzed by dividing into two groups as "within the first 24 hours" and "after the first 24 hours". The effect of this timing on clinical outcomes was evaluated.

The presence of dislocation at the time of initial presentation was determined retrospectively from patient records and the effect of dislocation on functional outcomes was analyzed. Patients with complete ankle dislocation were considered dislocated; subluxations were not considered dislocations.

Functional assessments were performed using the AOFAS ankle-hindfoot score at 6, 12, and 24 months postoperatively. The validity and reliability of the American Orthopaedic Foot and Ankle Society Ankle-Hindfoot Scale was performed by Akbaba et al.¹⁰ It is a widely used semi-subjective clinical measurement tool developed to evaluate functional results related to the ankle and hindfoot. The scale, which consists of 3 components, pain, function and alignment, is evaluated out of a total of 100 points.

RESULTS

Of the 44 patients included in the study, 24 (54.5%) were male and 20 (45.5%) were female. The median age of the patients was 35 years (range: 23–50). The right ankle was affected in 20 patients (45.5%), and the left ankle in 24 patients (54.5%). According to the Haraguchi classification, 13 patients (29.6%) had type 2 fractures, and 31 patients (70.4%) had type 3 fractures. Associated ankle dislocation was detected in 23 patients (52.3%), while no dislocation was observed in 21 patients (47.7%). Based on the time interval between trauma and surgery, 29 patients (65.9%) were operated within the first 24 hours, and 15 patients (34.1%) after 24 hours. The median time from trauma to surgery in these patients was recorded as 4 days (range: 2–7).

For PM fixation, cannulated screws were used in 19 patients (43.2%), and plates were used in 25 patients (56.8%). No statistically significant differences were observed between the plate and screw groups in terms of age, sex, side, Haraguchi type, presence of dislocation, syndesmosis involvement, fracture-to-operation time, or loss of reduction (all $p > 0.05$) (**Table 1**).

When comparing the plate and screw groups in terms of AOFAS scores, no significant differences were found between the groups at 6, 12, and 24 months ($p = 0.933$, $p = 0.610$, and $p = 0.809$, respectively). Median AOFAS scores were high in both groups, and functional outcomes were similar (**Table 2**).

In terms of the presence of dislocation, patients with dislocation had significantly lower AOFAS scores compared to those without dislocation. The median AOFAS score at 6 months was 92 (88–100) in the dislocation group and 96 (88–100) in the non-dislocation group, with the difference being statistically significant ($p = 0.015$). Similarly, the median AOFAS score at 12 months was 92 (88–97) in the dislocation group and 96 (88–100) in the other group ($p = 0.027$); at 24 months, the scores were 96 (88–97) and 97 (90–100), respectively ($p = 0.002$) (**Table 3**).

There was no significant difference in AOFAS scores according to whether the time from trauma to surgery was less than or greater than 24 hours (6th month $p = 0.358$; 12th month $p = 0.980$; 24th month $p = 0.860$) (**Table 4**).

Table 1. Analysis of the relationship between groups and variables

		Cannulated		Plate		Total		P
		n	%	n	%	n	%	
Sex	Male	11	57.89	13	52.00	24	54.55	0.692
	Female	8	42.11	12	48.00	20	45.45	
Age, median (min-max)		35 (26-50)		34 (23-48)		35 (23-50)		0.254
Side	Right	9	47.37	11	44.00	20	45.45	0.824
	Left	10	52.63	14	56.00	24	54.55	
Haraguchi	2	5	26.32	8	32.00	13	29.55	0.682
	3	14	73.68	17	68.00	31	70.45	
Dislocation	+	10	52.63	13	52.00	23	52.27	0.967
	-	9	47.37	12	48.00	21	47.73	
Fracture-to-operation time	After 24 hours	6	31.58	9	36.00	15	34.09	0.759
	Within 24 hours	13	68.42	16	64.00	29	65.91	
Fracture-to-operation time (days). (those operated after 24 hours), median (min-max)		6 (4-7)		4 (2-7)		4 (2-7)		0.224
Syndesmosis	+	5	26.32	7	28.00	12	27.27	0.901
	-	14	73.68	18	72.00	32	72.73	
Loss of reduction	+ (>2mm)	1	5.26	1	4.00	2	4.55	1.000
	-	18	94.74	24	96.00	42	95.45	

Min: Minimum, Max: Maximum

Table 2. Comparison of AOFAS scores between groups

	Cannulated	Plate	Total	p
AOFAS 6. month	96 (88-100)	95 (88-100)	96 (88-100)	0.933
AOFAS 12. month	96 (89-100)	96 (88-100)	96 (88-100)	0.610
AOFAS 24. month	96 (89-100)	96 (88-100)	96 (88-100)	0.809

AOFAS: American Orthopaedic Foot and Ankle Society

Table 3. Comparison of AOFAS scores based on dislocation status

	Dislocation (+)	Dislokasyon (-)	p
AOFAS 6. month	92 (88-100)	96 (88-100)	0.015
AOFAS 12. month	92 (88-97)	96 (88-100)	0.027
AOFAS 24. month	96 (88-97)	97 (90-100)	0.002

AOFAS: American Orthopaedic Foot and Ankle Society

Table 4. Comparison of AOFAS scores based on fracture-to-operation time

	After 24 hours	Within 24 hours	P
AOFAS 6. month	95 (88-97)	96 (88-100)	0.358
AOFAS 12. month	96 (88-100)	96 (88-100)	0.98
AOFAS 24. month	96 (88-100)	96 (89-100)	0.86

AOFAS: American Orthopaedic Foot and Ankle Society

DISCUSSION

In this study, the effects of plate and cannulated screw fixation methods used for posterior malleolar fixation in trimalleolar ankle fractures on clinical outcomes were examined, along with the impact of the time interval between trauma and surgery, and the presence of dislocation on AOFAS scores. Our findings indicate that there is no significant difference in clinical outcomes between fixation methods (screw or plate); however, the presence of dislocation negatively affects the results.

For many years, posterior malleolar fractures were evaluated solely based on fragment size, but nowadays, fracture morphology and the degree of intra-articular involvement have become more decisive in treatment planning.^{11,12} Although the Haraguchi classification provides guidance in the selection of surgical approach and fixation method, some studies have reported that these classifications do not always correlate directly with functional outcomes.^{3,4}

In our study, the majority of patients had Haraguchi types 2 and 3 fractures. This finding is consistent with reports stating that type 1 fractures are more stable and associated with better outcomes.¹³ However, subgroup analyses based on the Haraguchi classification were not performed in our study, which limits the assessment of potential clinical differences.¹⁴

When comparing screw and plate fixation methods in posterior malleolar fractures, although many studies report better anatomical reduction with plate fixation, no significant differences in functional scores have been observed.^{6,9} In our study as well, no statistically significant differences were found between the plate and screw groups in terms of AOFAS scores at 6, 12, and 24 months. This suggests that both fixation methods, when providing stable fixation, are functionally sufficient.¹⁵

Some biomechanical studies in the literature have reported that buttress plate application provides greater stability compared to screw fixation.^{16,17} However, this difference does not directly reflect in clinical outcomes.¹⁸ In our study, loss of reduction was observed in only two patients, one from the screw group and one from the plate group.

The presence of dislocation in our study was significantly associated with lower AOFAS scores. This indicates that dislocation leads to more extensive soft tissue damage and anatomical disruption in the joint surface.^{12,19} Indeed, some

studies have also reported that dislocation is associated with poorer functional outcomes and may increase the risk of developing osteoarthritis.^{2,4}

There is conflicting evidence in the literature regarding the timing of surgery. While some studies advocate that early surgery reduces complication rates,¹ others have found no clinically significant difference between surgeries performed before or after 24 hours.⁵ Our study supports the latter view; no significant impact of the time interval between trauma and surgery on AOFAS scores was observed.

The posterolateral approach is commonly used in posterior malleolar fractures to fix both the lateral and posterior components and has been reported to facilitate anatomical reduction.^{4,15} In our study, the posterolateral approach was used in all cases.

In conclusion, this study demonstrates that plate and screw fixation methods in posterior malleolar fixation yield similar functional outcomes, but the presence of dislocation is significantly associated with lower AOFAS scores. As also noted in some other studies, these findings highlight the critical importance of careful surgical planning and achieving anatomical reduction, especially in patients with dislocation, for clinical success.^{8,20}

Limitations

This study has some limitations. First, being a retrospective and single-center study may lead to potential selection bias. The relatively limited number of patients reduced the power of subgroup analyses. Furthermore, no detailed functional analysis was performed based on the Haraguchi classification, and advanced radiological assessments were not included. Although all surgeries were performed by the same surgical team, the choice of PM fixation method (plate or screw) was left to the individual surgeon's preference, which may lead to deviation from the principle of randomization and result in "surgeon-induced treatment selection bias." This is an important factor that may limit the generalizability of the results and the internal validity of the study. In addition, the effects of patient factors such as osteoporosis, smoking, and diabetes mellitus on treatment outcomes were not evaluated in the study, which constitutes an important limitation. Ignoring these factors may limit the generalizability of the results and the internal validity of the study.

CONCLUSION

In the surgical treatment of trimalleolar fractures, no significant difference in postoperative functional outcomes was found between plate and cannulated screw fixation methods for the posterior malleolar component. However, the presence of associated dislocation at the time of trauma negatively affected AOFAS scores, clearly demonstrating the adverse impact of dislocation on the postoperative clinical course. Surgical timing (whether performed within or after the first 24 hours) did not significantly affect functional outcomes. Based on the data obtained, rather than the choice of fixation method, achieving anatomical reduction and considering prognostic factors such as dislocation are more important for successful clinical outcomes.

ETHICAL DECLARATIONS

Ethics Committee Approval

Approval for the study was obtained from Ankara Bilkent City Hospital Medical Researches Scientific and Ethical Evaluation Committee No. 1 (Date: 26.03.2025, Decision No: TABED 1-25-1152).

Informed Consent

Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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